Environmental Product Declaration | Corrugated Steel Pipe Institute

Declaration Owner
Corrugated Steel Pipe Institute
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This EPD represents galvanized coil produced via electric arc furnace and blast-furnace steelmaking routes by several steel mills in North America that are then fabricated to corrugated steel conduit. Primary fabrication data was collected from CSPI member facilities located in Canada.

A complete list of manufacturers represented by this EPD can be found at the following site:
http://www.cspi.ca/manufacturers

Products
Industry-wide corrugated steel conduits

Declared Unit
The declared unit is one metric ton of corrugated steel conduit

EPD Number and Period of Validity
SCS-EPD-05002
EPD Valid June 4, 2018 through June 3, 2023

Product Category Rule
North American Product Category Rule for Designated Steel Construction Products

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PCR review, was conducted by	Tom Gloria, PhD, Industrial Ecology Consultants (Review Chair) Email: t.gloria@industrial-ecology.com
Approved Date: June 4, 2018 through June 3, 2023	
Independent verification of the declaration and data, according to ISO 14025:2006 and ISO 21930: 2007.	☐ internal ☑ external
Third party verifier	Jeremie Hakian, EPD Program Manager, SCS Global Services

ABOUT THE CORRUGATED STEEL PIPE INSTITUTE

The Corrugated Steel Pipe Institute (CSPI) is the Association in Canada, representing corrugated steel pipe (CSP) manufacturers and suppliers. Members come from seven different countries and five different continents. The CSPI is an impartial organization that works with our member manufacturers, plus engineers and municipalities around the world, to gather data and information to make CSPI the essential information resource for water and soil management in Canada.

CSPI promotes CSP and sustainable engineering practices as the most effective means of managing, directing, and containing the forces of soil and water. We help all CSP users maximize CSP's advantages of superior strength, versatility, and sustainability through flexible and versatile solutions. These CSP solutions preserve environments, both natural and built up, plus promote public safety, manage or detain water, and much more. Working closely with our members, CSPI also helps develop new product standards, recommended designs, installations, and applications. With more than 100 years of engineering expertise behind us, we provide assistance to the public, government officials, and engineers in finding the right CSP solutions for projects and obtaining the greatest value for today's dollar.

PRODUCT DESCRIPTION

Corrugated steel conduits are manufactured from Galvanized, Aluminized or Galvalume (zinc, aluminium or 55% aluminum 45% zinc coating) in a wide range of cross sectional shapes, sizes and end use applications as shown in Figure 1.

Shape	Range of Sizes	Common Uses
Round	150 mm – 15.8 m	Culverts, subdrains, sewers, service tunnels, etc. All plates same radius. For medium and high fills (or trenches)
Vertical ellipse 5% nominal	2,440 mm – 6,400 mm nominal; before elongating	Culverts, sewers, service tunnels, recovery tunnels. Plates of varying radii; shop fabrication. For appearance and where backfill compaction is only moderate
Pipe-arch	Span x Rise 450 mm x 340 mm – 7,620 mm x 4,240 mm	Where headroom is limited. Has hydraulic advantages at low flows.
Underpass	Span x Rise 1,755 mm x 2,005 mm – 1,805 mm x 2,490 mm	For pedestrians, livestock, or vehicles.
Arch	Span x Rise 1,520 mm x 810 mm – 20 m x 10 m	For low clearance large waterway openings and aesthetics.

Figure 1. *Typical shapes and uses of corrugated conduits*

In accordance with the PCR, the declared unit and product density are shown in Table 1.

Table 1. *Declared unit for corrugated steel conduits and the approximate density.*

Parameter	Value
Declared Unit	1 metric ton
Density	7,830 kg/m^3

A round corrugated steel pipe with profile of 125 x 25mm, 1800 mm diameter, 1.6 mm thickness and 11.8 m length has a mass of one metric ton.

MATERIAL CONTENT

Section 4 of the CSA G401 standard for corrugated steel pipe specifies the material content and properties. The following table provides additional typical steel specification information for corrugated steel conduits.

Material	Thickness and Coating Weight	Average (kg/m²)	Average content in total weight (%)
Non coated steel substrate	1.6 mm (16 gauge)	12.53	95.9%
Metallic coating (Zinc or equivalent)*	610 g/m² (G200)	0.54	4.1%
Total		13.07	100%

**Zinc is the typical metallic coating; other equivalent metallic coatings include Aluminized type 2 or Galvalume™ (55% Aluminum, 45% zinc)*

The following table from CSA G401 shows the chemical composition requirements of the steel substrate.

Chemical composition of steel*

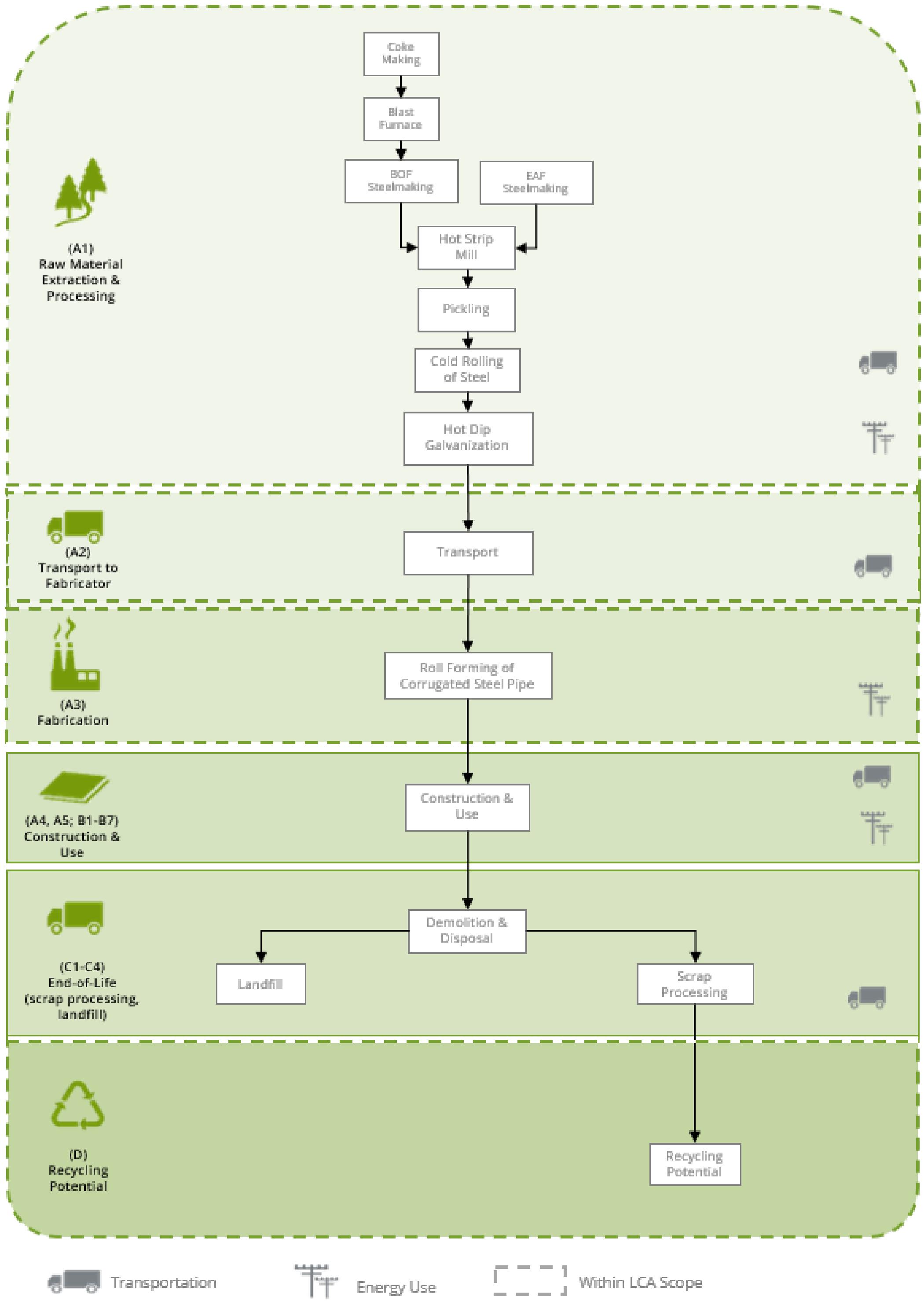
Element	Corrugated steel pipe and spiral rib pipe	Structural plate corrugated steel pipe	Deep corrugated structural plate	Chemical limits for longitudinal flange connections
Carbon**	0.15	0.10	0.25	0.22
Manganese	0.60	0.50	1.50	1.5
Phosphorus	0.08	0.08	0.08	0.04
Sulphur	0.05	0.05	0.04	0.05

**Heat analysis, percent, maximum*
*** To avoid brittle steel behaviour, a minimum of 0.02% carbon content shall be used.*

Steel products do not present inhalation, ingestion, or contact health hazards. These products do not include materials or substances that have a potential route of exposure to humans or flora/fauna in the environment.

PRODUCT LIFE CYCLE FLOW DIAGRAM

The diagram below is a representation of the most significant contributions to the production of corrugated steel conduits. This includes resource extraction, steelmaking, transport to fabrication shops, and product fabrication. The cradle-to-gate plus options (A1-A3 and D) system boundaries are shown in the diagram below.



LIFE CYCLE ASSESSMENT STAGES AND REPORTED INFORMATION

In accordance with the PCR, the life cycle stages included in this EPD are as shown below (X = included, MND = module not declared).

Product			Construction Process		Use							End-of-Life				Benefits & Loads Beyond the System Boundary
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Raw Material Extraction and	Transport to the Fabricator	Fabrication	Transport	Construction – Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction demolition	Transport	Waste processing	Disposal	Reuse, recovery, and/or recycling potential
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	X

X = included, MND = module not declared

The following life cycle stages are included in the EPD:

Raw Material Extraction and Processing (A1):
Raw material extraction, raw material transportation to steel mills, BOF and EAF steelmaking, hot rolling, pickling, cold rolling and galvanizing.

Transport to the Fabricator (A2):
A curtain side / 48,000 lb payload - 8b truck was used to model the transportation of the hot dip galvanized coils to the fabricators. A weighted average transportation distance of 288 km from the steel mill to the fabricators was used.

Fabrication (A3):
2016 corrugated steel conduit fabrication life cycle inventory data was collected from several corrugated steel pipe institute members located in Canada.

End of life Recycling (D):
Steel is currently the most recycled material in the world and can be recovered and recycled in a manner that results in no loss of the properties associated with the primary material. It is therefore important that the benefits associated with this recovery and recycling be recognized. When steel is recycled at the electric arc furnace, energy consumption decreases considerably as a result of avoiding primary (BOF) steelmaking production route and the associated virgin feedstock extraction. The credit acknowledges the true value of the product's energy footprint from a life cycle perspective. As the total primary energy demand decreases, the primary energy from renewables will increase because the energy mix used by the EAF has recourse to greater renewable energy resources.

The construction (A4-A5), Use (B1-B7) and End of life (C1-C4) were not included in this study. Since these stages are not covered in this EPD, the Reference Service Life (RSL) is not specified.

LIFE CYCLE IMPACT ASSESSMENT

Results are reported in Table 2 according to the LCIA methodologies of Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI version 2.1) and CML-IA version 4.1.

Table 2. *LCIA results for 1 metric ton of corrugated steel conduits.*

Impact Category	Units	PRODUCT STAGE			CREDITS AND BURDENS BEYOND THE SYSTEM BOUNDARY
		Steel Production	Transport to the Manufacturer	Manufacturing	Reuse, Recovery, Recycling Potential
		A1	A2	A3	D
Global Warming Potential	Metric ton CO_2 eq	2.21	0.0202	0.0311	-0.760
Ozone Depletion Potential	Metric ton CFC-11 eq	5.06×10^{-8}	1.79×10^{-13}	6.16×10^{-11}	5.39×10^{-9}
Acidification Potential	Metric ton SO_2 eq	0.0119	8.91×10^{-5}	1.61×10^{-4}	-1.49×10^{-3}
Eutrophication Potential	Metric ton N eq	5.11×10^{-4}	7.42×10^{-6}	1.51×10^{-5}	-6.52×10^{-5}
Photochemical Ozone Creation Potential	Metric ton O_3 eq	0.175	2.94×10^{-3}	1.57×10^{-3}	-0.0212
Depletion of Abiotic Resources (Elements)*	Metric ton Sb eq	4.57×10^{-5}	3.45×10^{-9}	1.85×10^{-8}	-2.18×10^{-6}
Depletion of Abiotic Resources (Fossil)	MJ, net calorific value	25,600	285	649	-7,280

*This indicator is based on assumptions regarding current reserves estimates. Users should use caution when interpreting results because there is insufficient information on which indicator is best for assessing the depletion of abiotic resources.

Resource Use:

The PCR requires that several parameters be reported in the EPD, including resource use, waste categories and output flows, and other environmental information. The results for these parameters per declared unit are shown in Table 3.

Table 3. *Resource use and wastes results for 1 metric ton of corrugated steel conduit.*

Parameter	Units	PRODUCT STAGE			CREDITS AND BURDENS BEYOND THE SYSTEM BOUNDARY
		Steel Production	Transport to the Manufacturer	Manufacturing	Reuse, Recovery, Recycling Potential
		A1	A2	A3	D
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ, net calorific value	1,080	7.11	332	-2.67×10^{-9}
Use of renewable primary energy resources used as raw materials	MJ, net calorific value	0.392	9.35×10^{-12}	62.3	0.00
Total use of renewable primary energy resources	MJ, net calorific value	1,080	7.11	332	-2.67×10^{-9}
Use of nonrenewable primary energy excluding nonrenewable primary energy resources used as raw materials	MJ, net calorific value	27,300	286	828	-9,150
Use of nonrenewable primary energy resources used as raw materials	MJ, net calorific value	0.00	0.00	0.00	0.00
Total use of nonrenewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ, net calorific value	27,3	286	828	-9,150
Use of secondary materials	Metric ton	0.446	0.00	0.00	0.00
Use of renewable secondary fuels	MJ, net calorific value	0.00	0.00	0.00	0.00
Use of nonrenewable secondary fuels	MJ, net calorific value	0.00	0.00	0.00	0.00
Net use of fresh water	m^3	14.9	0.00	0.0488	-5.21
Nonhazardous waste disposed	Metric ton	0.0136	0.00	1.77×10^{-5}	0.00
Hazardous waste disposed	Metric ton	4.26×10^{-4}	0.00	3.95×10^{-7}	-4.12×10^{-13}
Radioactive waste disposed	Metric ton	5.88×10^{-4}	6.28×10^{-7}	7.33×10^{-5}	2.45×10^{-7}
Components for re-use	Metric ton	0.00	0.00	0.00	0.00
Materials for recycling	Metric ton	0.446	0.00	2.54×10^{-4}	0.00
Materials for energy recovery	Metric ton	0.00	0.00	0.00	0.00
Exported energy	MJ per energy carrier	0.00	0.00	0.00	0.00

Disclaimer:

This Environmental Product Declaration (EPD) conforms to ISO 14025, 14040, ISO 14044, and ISO 21930.

Scope of Results Reported: *The PCR requires the reporting of a limited set of LCA metrics; therefore, there may be relevant environmental impacts beyond those disclosed by this EPD. The EPD does not indicate that any environmental or social performance benchmarks are met nor thresholds exceeded.*

Accuracy of Results: *This EPD has been developed in accordance with the PCR applicable for the identified product following the principles, requirements and guidelines of the ISO 14040, ISO 14044, ISO 14025 and ISO 21930 standards. The results in this EPD are estimations of potential impacts. The accuracy of results in different EPDs may vary as a result of value choices, background data assumptions and quality of data collected.*

Comparability: *EPDs are not comparative assertions and are either not comparable or have limited comparability when they cover different life cycle stages, are based on different product category rules or are missing relevant environmental impacts. Such comparisons can be inaccurate and could lead to the erroneous selection of materials or products which are higher impact, at least in some impact categories. Any comparison of EPDs shall be subject to the requirements of ISO 21930. For comparison of EPDs which report different module scopes, such that one EPD includes Module D and the other does not, the comparison shall only be made on the basis of Modules A1, A2, and A3. Additionally, when Module D is included in the EPDs being compared, all EPDs must use the same methodology for calculation of Module D values.*

Interpreting the Results in Module D: *The values in Module D include a recognition of the benefits or impacts related to steel recycling which occur at the end of the product's service life. The rate of steel recycling and related processes will evolve over time. The results included in Module D attempt to capture future benefits, or impacts, but are based on a methodology that uses current industry-average data reflecting current processes.*

SUPPORTING TECHNICAL INFORMATION

Data Sources

Primary data for hot-dip galvanized steel were unavailable and representative data taken from the worldsteel 2011 LCI database were used for the production of hot dip galvanized coil (module A1). All primary data for the transportation of steel coils to the fabricators in module A2 and the fabrication processes in module A3 were collected for the 2016 calendar year. See Table 4 for a description of data sources used for the LCA.

Table 4. *Data sources used for the LCA study.*

Module	Technology Source	Data Source	Region	Year
A1	GaBi 8	worldsteel / hot dip galvanized coil	North America	2011
A2	GaBi 8	Primary Data Collection	Canada	2016
A3	GaBi 8	Primary Data Collection	Canada	2016
D	GaBi 8	worldsteel / value of scrap	Global	2008
Other Processes	GaBi 8	Upstream GaBi datasets	varies	varies

Allocation

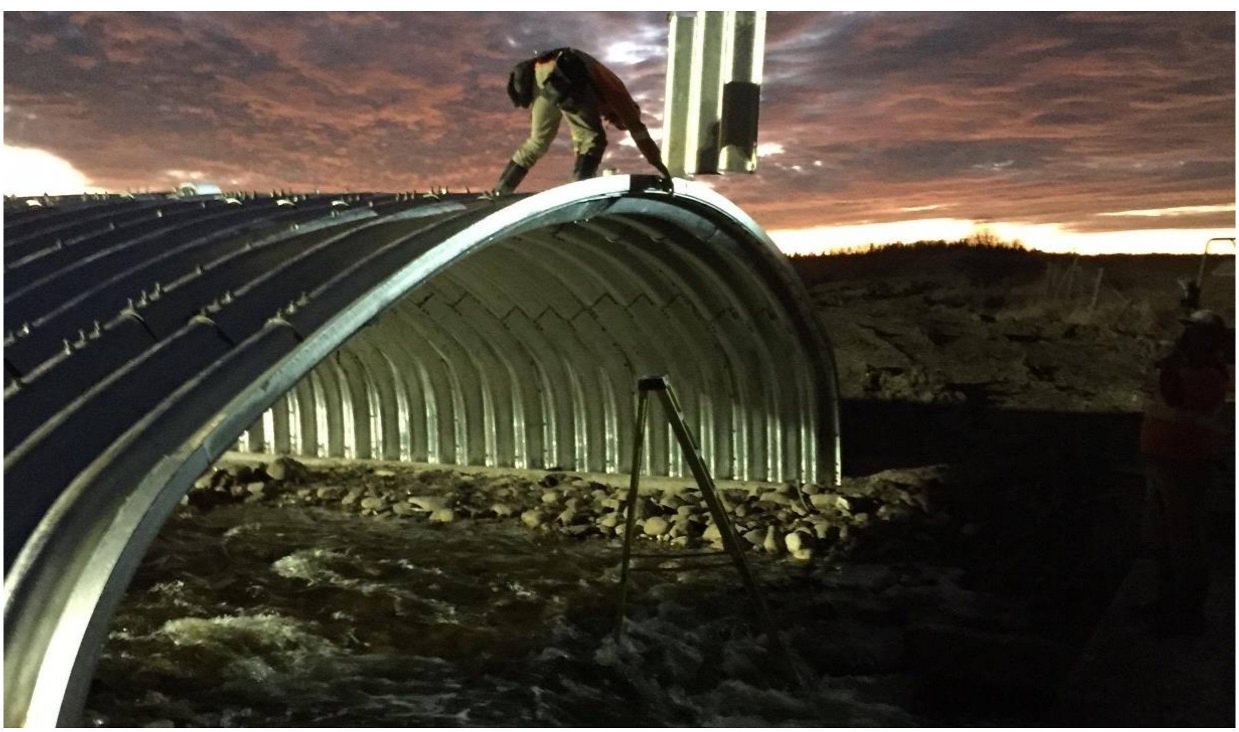
The LCA followed the allocation guidelines of ISO 14044 and the PCR. Co-products from hot-dip galvanized steelmaking were allocated using system expansion, as described in the worldsteel Association LCA Methodology Report (2011). Net steel scrap, accounting for scrap input to the product system and scrap generated from product manufacturers and at end-of-life, is modeled as a potential avoided burden and is reported as Module D.

Data Quality

Data Quality Parameter	Data Quality Discussion
Time-Related Coverage: Age of data and the minimum length of time over which data is collected	For Modules A1-A3, the data used are the most current available. The data representing HDG steel production (Module A1) is from within the last 10 years, although the generic data used may be as old as 15 years old. For Module A3, data is from 2016. Module D represents avoided steel production occurring many decades into the future, using current data on recycling rates, steel production, electricity grid mix, and emissions controls.
Geographical Coverage: Geographical area from which data for unit processes is collected to satisfy the goal of the study	The data sources used for Modules A1 to A3 are from North America, and so provide good geographical coverage. Module D uses global data to represent avoided steel production. Considering that scrap is a globally traded commodity and the significant volume of North American scrap exports, the global geographical coverage of the worldsteel value of scrap dataset is appropriate.
Technology Coverage: Specific technology or technology mix	For Module A1, the technological coverage is considered good, as the data is based on a representative mix of U.S. and Canadian EAF and BOF steel mills. For Modules A2 and A3, technology coverage is good. For Module D, technology coverage is based on current practices, consistent with the guidance of EN 15804.
Precision: Measure of the variability of the data values for each data expressed	None of the datasets used to assess results for any module include statistical information regarding the confidence in results, so it is not possible quantitatively to evaluate the precision in results, which is affected by sampling variability and measurement error.
Completeness: Percentage of flow that is measured or estimated	All datasets included are considered to have a high degree of completeness, except for the lack of data on net water use for Module A1. As this module is expected to account for a larger degree of net water use than the other modules, this is a clear study limitation.
Representativeness: Qualitative assessment of the degree to which the data set reflects the true population of interest	The representativeness of Modules A1 to A3 and D is good overall. Considering that scrap is a globally traded commodity and the significant North American scrap exports, the global geographical coverage of the worldsteel value of scrap dataset is appropriate.
Consistency: Qualitative assessment of whether the study methodology is applied uniformly to the various components of the analysis	For all modules, assumptions and methodology are largely consistent. The approach of system expansion is used, in lieu of allocation, as much as possible.
Reproducibility: Qualitative assessment of the extent to which information about the methodology and data values would allow an independent practitioner to reproduce the results reported in the study	Provided the practitioner had access to the same data sources described in the report, the results would be reproducible.
Sources of the Data: Description of all primary and secondary data sources	The sources of the data provided by the worldsteel Association used to model Module A1 are presented as aggregated values, with no detail on the contribution of individual flows or unit processes. The same applies to the aggregated data used to model Module D.
Uncertainty of the Information: Uncertainty related to data, models, and assumptions	It is not possible to assess the uncertainty of Modules A1 and D, due to the worldsteel data being provided in an aggregated manner. For the other modules, the uncertainty is likely to be low as this is primary data collected from the fabricators.
Cut-off Criteria	All energetic inputs to the process stages were recorded, including heating fuels, electricity, steam and compressed air. At least 99.9% of material inputs to each process stage were included. Wastes representing less than 1% of total waste tonnage for given process stages were not recorded unless treated outside of the site.

REFERENCES

1. Bare, J., et al. TRACI – The Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts. Journal of Industrial Ecology. Volume 6, no. 3-4 (2003). http://mitpress.mit.edu/jie
2. CML-IA database v4.1. Institute of Environmental Sciences (CML). University of Leiden, Netherlands. October 2012.
3. EN 15804:2012+A1:2013. Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products. 2013.
4. Lipkowski S., ArcelorMittal Global R&D, Life Cycle Assessment of Corrugated Steel Pipe Background Report, March 2018
5. ISO 14040: 2006 Environmental Management – Life cycle assessment – Requirements and Guidelines
6. ISO 14044: 2006 Environmental Management – Life cycle assessment – Requirements and Guidelines.
7. ISO 21930: 2007 Sustainability in building construction – Environmental declaration of building products.
8. North American Product Category Rule for Designated Steel Construction Products. SCS Global Services. Version 1.0. May 2015.
9. LCA methodology report, worldsteel association (2011). ISBN 978-2-930069-66-1.
10. Addendum to the North American Product Category Rule for Designated Steel Construction Products, Guidance for Corrugated Steel Pipe, Version 1.0, May 11, 2018
11. CSA G401-14, Corrugated Steel Pipe Products, March 2014
12. SCS Type III Environmental Declaration Program: Program Operator Manual v9.0. January 2018. SCS Global Services.



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